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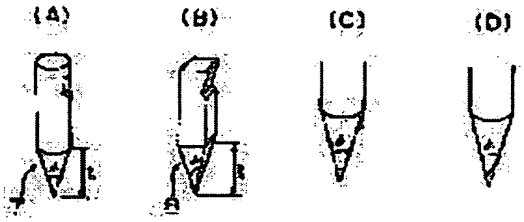
(54) SILICON SEED CRYSTALS, THEIR PRODUCTION AND PROCESS FOR PRODUCING SILICON SINGLE CRYSTAL BY USING THESE SEED CRYSTALS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide silicon seed crystals and process for producing the same capable of improving the success rate of single crystallization in a process for producing the silicon single crystal without executing so-called necking in the process for producing the silicon single crystal by a Czochralski method.
SOLUTION: The shape at the front end of the silicon seed crystal to be brought into contact with a silicon melt in the process for producing the silicon single crystal by the Czochralski method is formed to a pointed shape or a shape formed by cutting off its pointed front end. The max.. vertex α thereof is ≥3 to ≤28°. In such a case, the front end may be. etched or may be formed by using the round part formed by the Czochralski method. A silicon single crystal rod of a desired diameter is grown by using such silicon seed crystal without executing the necking.



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CLAIMS

[Claim(s)]
[Claim 1] Silicon seed crystal characterized by for the configuration of a point of making silicon melt contacting being a configuration which cut off the configuration where it sharpened, or the sharp tip in the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method, and the maximum vertical angle being 28 or less degrees.
[Claim 2] Silicon seed crystal according to claim 1 with which said maximum vertical angle is characterized by being 28 or less degrees 3 times or more.
[Claim 3] Silicon seed crystal according to claim 1 or 2 characterized by etching the point contacted to said silicon melt at least.
[Claim 4] Silicon seed crystal according to claim 3 characterized by making the amount of etching removal into 300 microns or more.
[Claim 5] Silicon seed crystal according to claim 1 or 2 characterized by rounding off and using the section as a point which was formed with the Czochrlski method, and in which seed crystal sharpened.
[Claim 6] The manufacture approach of the silicon seed crystal characterized by to etch the point contacted to silicon melt at least after processing mechanically into said request seed-crystal configuration the silicon single crystal ingot from which the configuration of a point make silicon melt contact serves as a material of seed crystal in the manufacture approach of the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method which is the configuration which cut off the configuration where of it sharpened, or the sharp tip.
[Claim 7] The manufacture approach of the silicon seed crystal characterized by to choose the thing which formed the silicon single crystal ingot from which the configuration of a point make silicon melt contact serves as a material of seed crystal in the manufacture approach of the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method which is the configuration which cut off the configuration where of it sharpened, or the sharp tip with the Czochrlski method, and which rounds off and has the section, and to use this rounding-off section as a point in which seed crystal sharpened.
[Claim 8] By pulling up slowly, rotating this, after contacting seed crystal to silicon melt In the manufacture approach of the silicon single crystal by the Czochrlski method into which a silicon single crystal rod is grown up The seed crystal of a publication is used for any 1 term of claim 1 thru/or claim 5 as this seed crystal. It fuses until the point of seed crystal serves as a desired size by dropping this seed crystal with a low speed, after contacting the tip of this seed crystal to silicon melt calmly first. Then, the manufacture approach of the silicon single crystal characterized by what is made to raise the silicon single crystal rod of the diameter of a request, without necking by raising this seed crystal slowly.
[Claim 9] By pulling up slowly, rotating this, after contacting seed crystal to silicon melt In the manufacture approach of the silicon single crystal by the Czochrlski method into which a silicon single crystal rod is grown up The seed crystal manufactured by the approach according to claim 6 or 7 as this seed crystal is used. It fuses until the point of seed crystal serves as a desired size by dropping this seed crystal with a low speed, after contacting the tip of this seed crystal to silicon melt calmly first. Then, the

manufacture approach of the silicon single crystal characterized by what is made to raise the silicon single crystal rod of the diameter of a request, without necking by raising this seed crystal slowly.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is the manufacture approach of the silicon single crystal by the Czochrlski method (Czochralski Method= CZ process), and it relates to the silicon seed crystal used by this approach, and its manufacture approach in the approach of manufacturing a silicon single crystal, without performing the so-called seed diaphragm (necking).
[0002]
[Description of the Prior Art] Conventionally, after contacting this to silicon melt in manufacture of the silicon single crystal by the Czochrlski method, using single crystal silicon as seed crystal, a single crystal rod is grown up by pulling up slowly, making it rotate. Under the present circumstances, when contacting seed crystal to silicon melt, in order to extinguish the rearrangement generated in high density in seed crystal by the thermal shock, a seed diaphragm (necking) is performed, subsequently to desired aperture, a crystal is fattened until it becomes and the silicon single crystal is pulled up. such a seed diaphragm -- DashNecking -- it is widely known as law and considers as the common sense in the case of pulling up a silicon single crystal rod with the Czochrlski method.
[0003] That is, as the configuration of the seed crystal used conventionally is shown in drawing 4 (A) and (B), the notching section for setting to a seed electrode holder should be put into a diameter or the one side of the shape of an about 8-20mm cylinder, or a prismatic form thing, and the tip configuration of the lower part which will contact silicon melt first serves as a flat side. And in order to bear the weight of the single crystal rod of the amount of Takashige and to pull up safely, it is difficult for the size of seed crystal to make it thin below at the above.
[0004] Since the heat capacity at the tip in contact with melt is large, seed crystal produces a temperature gradient rapid in a crystal at the moment of contacting melt, and high density is made to generate a slip rearrangement in the seed crystal of such a configuration. Therefore, said necking is needed, in order to eliminate this rearrangement and to raise a single crystal.
[0005] This Dash After the Necking method contacts seed crystal to silicon melt, it makes a diameter once thin at about 3mm, forms a converging section, extinguishes the rearrangement spread from the slip rearrangement introduced into seed crystal, and obtains the single crystal of a non-rearrangement.
[0006] However, even if it chooses various necking conditions, in order to form a-less rearrangement by such approach, the minimum diameter of 5-6mm needed to narrow down, reinforcement was not enough to hang the single crystal rod formed into Shigekazu Taka with increase of the diameter of a silicon single crystal in recent years, and support, this thin converging section fractured during crystal rod raising, and there was a possibility of producing the serious accident of a single crystal rod falling.
[0007] Then, in raising of a large diameter in recent years and the amount single crystal rod of Takashige, development of the approach using a crystal maintenance device is furthered (for example, refer to JP,5-65477,B). As mentioned above, since necking is indispensable because of rearrangement [non-]-izing and this approach cannot strengthen reinforcement of a seed converging section, it holds a growth crystal rod directly mechanically instead.

[0008] However, since such an approach is what holds directly the single crystal rod which grows slowly, rotating at an elevated temperature, equipment will become complicated and expensive and it also produces a heat-resistant problem. It is very difficult to hold moreover, without actually giving vibration etc. to a growth crystal, and since a growth crystal will be made to polycrystal-ize or the equipment which is right above [further hot / silicon melt] complicated, and has devices, such as rotation and sliding, will be arranged, there are various problems of polluting a crystal with a heavy-metal impurity.
[0009] In order to solve such a problem, these people proposed JP,5-139880,A and invention like Japanese Patent Application No. No. 87187 [eight to] previously. It excels, and by [whose slip rearrangement which enters when the configuration of the point of seed crystal is made into the configuration which has a wedge shape or a centrum and seed crystal contacts silicon melt is made] decreasing, even if this invention makes the diameter of a converging section comparatively thick, non-rearrangement-ization is enabled, and it has it and raises the reinforcement of a converging section.
[0010] since the size of a converging section can be made thick by this approach, also although kicked, it may neck, there may be no change in forming the converging section with a slip rearrangement whose improvement in the reinforcement of a converging section can be performed to some extent, reinforcement may become inadequate for raising of a large diameter and the single crystal rod which long-picture-izes, for example, amounts to 150kg or more recent years increasingly, and it has not resulted in fundamental solution.
[0011] Then, these people as what solves such a problem, without forming the converging section by necking which poses the first problem on reinforcement A crystal can be made to single-crystal-ize. A large diameter and Shigekazu Taka's long picture silicon single crystal Without using complicated equipment like a crystal maintenance device, it succeeded in developing the silicon seed crystal used for the manufacture approach of a silicon single crystal and this which can be pulled up very easily, and proposed previously (Japanese Patent Application No. No. 17687 [nine to]).
[0012] The configuration of a point of making silicon melt contacting as seed crystal this approach After being the configuration which cut off the configuration where it sharpened, or the sharp tip and contacting the tip of this seed crystal to silicon melt calmly first, It is the manufacture approach of the silicon single crystal of making the silicon single crystal rod of the diameter of a request raising, without fusing until the point of seed crystal serves as a desired size by dropping seed crystal with a low speed, and necking by raising seed crystal slowly after that.
[0013]
[Problem(s) to be Solved by the Invention] Although the above-mentioned various problems accompanying forming a converging section could be solved fundamentally and it excelled in the above-mentioned approach extremely since it did not neck, the subsequent running test showed that a rearrangement might be easy to be introduced into seed crystal depending on the configuration of seed crystal, and the manufacture approach at the time of contact of the point of seed crystal, and melting, training of a subsequent single crystal might become difficult, and the success percentage might become low.
[0014] Then, let it be a key objective for this invention to offer the silicon seed crystal which was made in view of such a trouble, this invention is the manufacture approach of the silicon single crystal by the Czochrlski method, and can raise the success percentage of the single-crystal-izing in the approach of manufacturing a silicon single crystal, without performing the so-called seed diaphragm (necking), and its manufacture approach.
[0015]
[Means for Solving the Problem] Invention indicated to claim 1 of this invention in order to solve the above-mentioned technical problem is silicon seed crystal characterized by being the configuration where the configuration of a point of making silicon melt contacting cut off the configuration where it sharpened, or the sharp tip, and the maximum vertical angle being 28 or less degrees in the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method.
[0016] Thus, while considering as the configuration which cut off the configuration where the

configuration of the point of seed crystal was sharpened, or the sharp tip When contacting the tip of seed crystal to silicon melt first by making the maximum vertical angle into 28 or less degrees, the touch area to melt is fully small. Since the heat capacity of a point is also small enough Since a thermal shock or a rapid temperature gradient is not formed in seed crystal, a slip rearrangement is not introduced. Moreover, since the touch area of the seed crystal in melt and melt increases gradually when fusing until it drops seed crystal with a low speed after that and the point of seed crystal serves as a desired size and seed crystal can be fused to a request size, without forming a rapid temperature gradient in seed crystal, a slip rearrangement is not introduced in seed crystal at the time of melting. Therefore, the contact to the melt of seed crystal and melting become certainly possible, without generating a slip rearrangement, and a single crystal rod can be raised, without necking after that.

[0017] And as indicated to claim 2 in this case, it is desirable to make the maximum vertical angle of seed crystal into 28 or less degrees 3 times or more.

[0018] Thus, 3 times or more, then the slip rearrangement installation prevention effectiveness of the maximum vertical angle of seed crystal are enough, and it is desirable to consider as the include-angle range of the above-mentioned maximum vertical angle from points, such as the ease of compaction of melting time amount and seed crystal manufacture and reinforcement of a point.

[0019] Moreover, in invention indicated to claim 3 of this invention, the point of silicon seed crystal contacted to silicon melt at least should be etched.

[0020] Thus, since distortion of the thing which etched the point contacted to the silicon melt of seed crystal, then the front face introduced when processing seed crystal mechanically and manufacturing it, for example is removable, when contacting or fusing a seed crystal point, a slip rearrangement is not introduced owing to this, more certainly, by the non-rearrangement, it can contact and seed crystal can be fused.

[0021] In this case, as especially indicated to claim 4, it is desirable to make the amount of etching removal into 300 microns or more.

[0022] If 300 microns or more are etched, surface distortion can be removed certainly and a slip rearrangement will not be introduced into seed crystal owing to this.

[0023] Moreover, it is by invention indicated to claim 5 of this invention. It rounded off and the section was used as the silicon seed crystal used as a point which was formed with the Czochrlski method, and in which seed crystal sharpened.

[0024] It becomes unnecessary thus, to carry out the above-mentioned etching, without surface [which was formed with the Czochrlski method as a point of seed crystal] distortion which mechanical processing etc. is unnecessary if it rounds off and the section is used, and is produced from such processing existing.

[0025] Next, the configuration of a point of making silicon melt contacting invention indicated to claim 6 of this invention In the manufacture approach of the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method which is the configuration which cut off the configuration where it sharpened, or the sharp tip After processing mechanically the silicon single crystal ingot used as the material of seed crystal into said request seed crystal configuration, it is the manufacture approach of the silicon seed crystal characterized by etching the point contacted to silicon melt at least.

[0026] Thus, if manufacture of seed crystal is etched after processing a silicon single crystal ingot into a request configuration mechanically, while being able to obtain the seed crystal which certainly had a request point configuration, what does not have distortion in the front face can be manufactured.

[0027] Moreover, the configuration of a point of making silicon melt contacting invention indicated to claim 7 of this invention In the manufacture approach of the silicon seed crystal used in case a silicon single crystal rod is manufactured with the Czochrlski method which is the configuration which cut off the configuration where it sharpened, or the sharp tip It is the manufacture approach of the silicon seed crystal characterized by choosing the thing which formed the silicon single crystal ingot used as the material of seed crystal with the Czochrlski method, and which rounds off and has the section, and using this rounding-off section as a point in which seed crystal sharpened.

[0028] While it is easy since it is not necessary to form a point by machining if manufacture of seed crystal is made into the thing which formed the silicon single crystal ingot with the Czochrlski method and which rounds off and has the section and this rounding-off section is used as a point in which seed crystal sharpened, it becomes saving of a material and distortion is not shown in the front face of the made object.

[0029] And invention indicated to claim 8 of this invention By pulling up slowly, rotating this, after contacting seed crystal to silicon melt In the manufacture approach of the silicon single crystal by the Czochrlski method into which a silicon single crystal rod is grown up The seed crystal of a publication is used for any 1 term of claim 1 thru/or claim 5 as this seed crystal. It fuses until the point of seed crystal serves as a desired size by dropping this seed crystal with a low speed, after contacting the tip of this seed crystal to silicon melt calmly first. Then, it is the manufacture approach of the silicon single crystal characterized by what is made to raise the silicon single crystal rod of the diameter of a request, without necking by raising this seed crystal slowly.

[0030] Invention indicated to claim 9 of this invention moreover, by pulling up slowly, rotating this, after contacting seed crystal to silicon melt In the manufacture approach of the silicon single crystal by the Czochrlski method into which a silicon single crystal rod is grown up The seed crystal manufactured by the approach according to claim 6 or 7 as this seed crystal is used. It fuses until the point of seed crystal serves as a desired size by dropping this seed crystal with a low speed, after contacting the tip of this seed crystal to silicon melt calmly first. Then, it is the manufacture approach of the silicon single crystal characterized by what is made to raise the silicon single crystal rod of the diameter of a request, without necking by raising this seed crystal slowly.

[0031] thus, since the sharp seed crystal of a point configuration with which a slip rearrangement is not introduced at the time of melting can be certainly obtained at the time of seed crystal contact according to the manufacture approach of the seed crystal of this invention, and seed crystal, if a silicon single crystal is made to raise, without necking using this, the success percentage will be markedly alike and will improve.

[0032]

[Embodiment of the Invention] Hereafter, although the gestalt of operation of this invention is explained, this invention is not limited to these. In order to make a single crystal raise, without necking in the Czochrlski method, when contacting seed crystal to silicon melt and fusing it slowly by desired Mr. Futoshi after that, it is indispensable to seed crystal that a slip rearrangement does not occur. Therefore, the success percentage of the approach of making a single crystal raising, without necking is applied to how a slip rearrangement is not generated at the time of the contact to the melt of seed crystal, and melting.

[0033] Then, this invention persons find out this invention variously about the configuration and the manufacture approach of the seed crystal which does not generate a slip rearrangement certainly as a result of experimental research, when contacting and fusing to such silicon melt.

[0034] It is necessary to consider as the configuration which cut off the configuration where the configuration of the point of seed crystal was sharpened, or the sharp tip, as a fundamental configuration of the seed crystal used for the approach of raising a single crystal rod, without necking. When it was such a configuration and the tip of seed crystal contacts silicon melt first, the touch area to melt is small, and it is because a thermal shock or a rapid temperature gradient is not formed in seed crystal since the heat capacity of a point is small, so a slip rearrangement is not introduced.

[0035] And if it fuses until it drops seed crystal slowly after that and the point of seed crystal serves as a desired size, since the touch area of the seed crystal in melt and melt increases gradually, seed crystal can be fused without forming a rapid temperature gradient in seed crystal, and a slip rearrangement will not be introduced in seed crystal at the time of melting.

[0036] As a more concrete configuration of such seed crystal, even the following matter had become clear by the previous proposal.

(1) As a configuration of the seed crystal point of the configuration which cut off the configuration where it sharpened, or the sharp tip, considering as a cone or a pyramid configuration is a desirable

thing.
(2) For die-length t of the cone section 7 of the seed crystal shown in drawing 3 in this case, and the pyramid section 8, although it is arbitrary, the size of seed crystal is [two to 8 times, then] a good thing more preferably about 1 to 10 times.
(3) The pyramid configuration of a point is also good also as a triangular pyramid, a square drill, or a multiple drill beyond it. Moreover, the thing for which it is good also as what the cross-section configuration of the body section of seed crystal and the cross-section configuration of a point did not need to be made in agreement, and processed the point of the seed crystal of a prism configuration on the cone, and a configuration can be combined with arbitration.
(4) The configuration which cut off the sharp tip not only like the configuration where the tip configuration of seed crystal as shown in drawing 3 (A) and (B) sharpened but like drawing 3 (C) is sufficient. And how to cut off a tip is also arbitrary, when cutting off horizontally, it is not restricted, for example, you may cut off aslant like drawing 3 (D). In this case, for the area of the field which contacts silicon melt to the beginning at the tip of seed crystal, it is a good thing that carrying out to below 9pi (mm2) carries out to below 2.25pi (mm2) at best still more preferably.
[0037] The approach of manufacturing the single crystal rod which does not neck with the concrete configuration of the above-mentioned seed crystal can be enforced. Therefore, also in this invention, the above-mentioned conditions are conditions applied as it is fundamentally. However, in order for dispersion to be in the success percentage and to contact and fuse seed crystal to silicon melt by the non-rearrangement more certainly, the device of still much more seed crystal configuration and specification are required only of such conditions.
[0038] Then, this invention persons investigated in detail about the success percentage of the approach of growing up a single crystal rod, without necking with the acutance of image of the point of seed crystal. This investigates the rate of rearrangement[non-]-izing of the maximum vertical angle of the point of seed crystal, and a single crystal rod.
[0039] Then, when the maximum vertical angle of a seed crystal point exceeded 28 degrees, it turned out that success percentage falls rapidly. Although the detail of the reason is unknown, if the maximum vertical angle exceeds 28 degrees, since the heat capacity of a point is not small enough, when silicon melt is contacted, even if a rapid temperature gradient is formed [whether a slip rearrangement occurs and] of a thermal shock at the time of subsequent melting since the rate of increase of a touch area is large and it reduces a metaphor melting rate by it, it will be thought that a slip rearrangement may occur. Therefore, in the seed crystal concerning this invention, in order that making the maximum vertical angle of a point into 28 or less degrees may raise success percentage, it is desirable.
[0040] In this case, as it is indicated in drawing 1 as the maximum vertical angle said by this invention, it is the vertical angle of the point which carries out melting to silicon melt, and the greatest vertical angle alpha which can be taken from that cross-section configuration is said. therefore, the case where a point like drawing 1 (A) is a configuration like a cone -- vertical-angle = maximum vertical-angle = -- although it is fixed, when a point like drawing 1 (B) is a configuration like a pyramid, the vertical angle by the side of a diagonal cross section is pointed out.
[0041] Moreover, even if it is in this invention, the configuration which cut off the sharp tip not only like the configuration where the tip configuration of seed crystal as shown in drawing 1 (A) and (B) sharpened but like drawing 1 (C) is sufficient as the configuration of a point. And how to cut off a tip is also arbitrary, when cutting off horizontally, it is not restricted, for example, you may cut off aslant like drawing 1 (D). In this case, the semantics of said maximum vertical angle in this invention is shown by the maximum vertical angle alpha before cutting off irrespective of the existence of such cutoff.
[0042] It is desirable to consider as 3 times or more from a practical viewpoint on the other hand, although it will be good the more the more this maximum vertical angle alpha is small from a point that a slip rearrangement is not introduced into seed crystal.
[0043] If this is radicalized to 3 times in the maximum vertical angle of seed crystal, the slip rearrangement installation prevention effectiveness will be enough, a weak and hard silicon single crystal processing-top will be difficult for being radicalized in a tip in remainder, and it will be because

the problem on the handling of breakage etc. arises. And it is because die-length t of the point which should be carried out melting becomes longer as radicalized in a point, so the melting time amount of a point becomes long and the manufacture top of a single crystal rod also becomes what has many futility.

[0044] Next, about the manufacture approach of the seed crystal of this invention of having such a configuration, the silicon single crystal ingot used as the material of seed crystal is processed mechanically, it is the configuration where the request configuration, i.e., the configuration of a point of making silicon melt contacting, cut off the configuration where it sharpened, or the sharp tip, and the maximum vertical angle is just 28 or less degrees.
[0045] However, in this way, when a silicon single crystal ingot is mechanically processed into a request configuration and manufacture of seed crystal is produced, processing distortion will arise on the front face. A slip rearrangement will produce seed crystal from this processing distortion in silicon melt at the time of contact and melting, and such processing distortion will reduce the rate of rearrangement[non-]-izing, though the configuration of the point of metaphor seed crystal is the configuration of the above-mentioned request, if it does not remove completely.
[0046] Since it was the approach which a slip rearrangement generates in a converging section from the first in this point and the Czochrlski method which performs the conventional necking, generating of the slip rearrangement by this processing distortion was not so important, but since it is necessary to suppress generating of the slip rearrangement of seed crystal completely in this invention, removal of this processing distortion is important.
[0047] And what is necessary is just to etch the point contacted to silicon melt at least, after processing a request configuration mechanically, in order to remove surface treatment distortion. According to etching, the processing distortion of a front face is certainly [simply and] removable.
[0048] In this case, according to etching, although it does not generate only by mechanical processing, since etching removal of the whole front face is carried out, it can double and surface distortion can be removed, even if distortion other than the above-mentioned processing distortion exists.
[0049] And although etching should just dip the whole seed crystal in an etching reagent, it is necessary to etch the point which will contact silicon melt and will be fused at least. Although it will not be limited especially if it is the object which can etch silicon as an etching reagent, mixed acids, such as a fluoric acid + nitric acid, can be used, for example.
[0050] In this case, as an amount of etching removal, considering as 300 microns or more is desirable. The processing distortion by mechanical processing is deep, and it is because it has generally reached to the about 200-300 micron depth of surface. Therefore, if 300 microns or more are etched, surface distortion can be removed certainly and a slip rearrangement will not be introduced into seed crystal owing to this.
[0051] In this way, since the seed crystal manufactured becomes what does not have distortion in the front face while being the thing of a point configuration with request acutance of image, when contacting or fusing a seed crystal point, possibility that a slip rearrangement will be introduced becomes still lower, and it can contact and fuse seed crystal by the non-rearrangement more certainly.
[0052] Moreover, as other manufacture approaches of the seed crystal concerning this invention, a request point configuration may not be formed by mechanical processing, but the rounding-off section made to raise with the usual Czochrlski method may be used. This chooses the thing which formed the silicon single crystal ingot used as the material of seed crystal with the Czochrlski method and which rounds off and has the section, and uses this rounding-off section as a point in which seed crystal sharpened.
[0053] For example, as shown in drawing 2 , after contacting seed crystal 1 to melt with the usual Czochrlski method, necking is performed, a converging section 3 is formed and formed into a-less rearrangement, a diameter is enlarged after that, it grows up for a while for a desired diameter (diameter of seed crystal), the rounding-off section 6 is formed after that, and growth of a single crystal is ended. The made small rounding-off section of a crystal is used as a point of seed crystal, and in the opposite side of the rounding-off section, if the notching section for setting seed crystal to a seed electrode holder

is processed, seed crystal with the request point configuration of this invention can be manufactured.
[0054] Thus, since distortion does not exist in the seed crystal made by becoming saving of a material on a front face while it is easy since it is not necessary to form a point by machining if it rounds off and the section 6 is used as a point which was produced with the Czochrlski method and in which seed crystal sharpened, there is an advantage that it is not necessary to etch as mentioned above.
[0055] In this case, as it is necessary to perform no formation of the rounding-off section by the Czochrlski method only for accumulating making seed crystal as mentioned above and the dotted line of drawing 2 (B) shows, it cannot be overemphasized that you may produce using the rounding-off section of the silicon single crystal rod for semiconductor wafers with which manufacture is usually performed. Since the rounding-off section of the usual single-crystal-silicon rod does not fill a request diameter, it is discarded by it, and also in the semantics, it can also become saving of an ingredient and can be extremely manufactured by low cost.
[0056] And the seed crystal manufactured by the seed crystal or this invention approach of this invention of having the above-mentioned property is used. It fuses until the point of seed crystal serves as a desired size by dropping this seed crystal with a low speed, after contacting the tip of seed crystal to silicon melt calmly first. Then, if it is made to make the silicon single crystal rod of the diameter of a request raise, since a slip rearrangement will not be certainly introduced at the time of melting at the time of seed crystal contact, without necking by raising this seed crystal slowly without necking, the success percentage which can raise a silicon single crystal is markedly alike, and improves.
[0057]
[Example] Next, although the example and the example of a comparison of this invention are shown, this invention is not limited to these.
(An example, example of a comparison) The maximum vertical angle of the point of seed crystal was changed, and the success percentage of rearrangement[non-]-izing at the time of making a single crystal raise was investigated, without necking. After processing it mechanically in the bearing <100> in the shape of [which has the vertical angle of versatility / point / the /, using the thing of 10mm angle as seed crystal] a cone, what etched the whole seed crystal in the etching reagent of a fluoric acid + nitric acid was used.
[0058] Using such seed crystal, seed crystal was first held for 20 minutes right above [silicon melt], and the preheating was fully added. Then, after contacting the tip of seed crystal to silicon melt calmly by making it descend at the rate of 2 mm/min, continue into melt and it was made to descend at the same rate, and it fused until the diameter of the point of seed crystal was set to about 6mm. After fattening a crystal to the diameter of about 100mm immediately, without necking by beginning to raise seed crystal slowly from here, the body section was grown up about 10cm. And it rounded off at the end, the section was formed, and training of a silicon single crystal rod was terminated.
[0059] The success percentage was computed by the number ratio of whether the made single crystal rod to the number of the single crystal rods made to raise is the single crystal of a non-rearrangement. A result is shown in drawing 5 .
[0060] The maximum vertical angle of success percentage of seed crystal is high below 28 degrees so that clearly from the above-mentioned result, but when 28 degrees is exceeded, it turns out that success percentage falls rapidly.
[0061] In addition, this invention is not limited to the above-mentioned operation gestalt. The above-mentioned operation gestalt is instantiation, and no matter it may be what thing which has the same configuration substantially with the technical thought indicated by the claim of this invention, and does the same operation effectiveness so, it is included by the technical range of this invention.
[0062] for example, MCZ to which this invention impresses a magnetic field at the time of a pull-up of not only the usual Czochrlski method but a silicon single crystal -- not only the Czochrlski method usual to vocabulary called the Czochrlski method which was used by this detail letter to say nothing of being applicable also like law (Magnetic field applied Czochralski crystal growth method) but MCZ -- law is also included.
[0063]

[Effect of the Invention] according to the manufacture approach of the seed crystal of this invention, and seed crystal, the seed crystal which can boil markedly the success percentage of the approach of making a silicon single crystal rod raising, and can raise it with the Czochrlski method, without necking can be obtained. Consequently, a large diameter and Shigekazu Taka's long picture silicon single crystal can be pulled up very easily.

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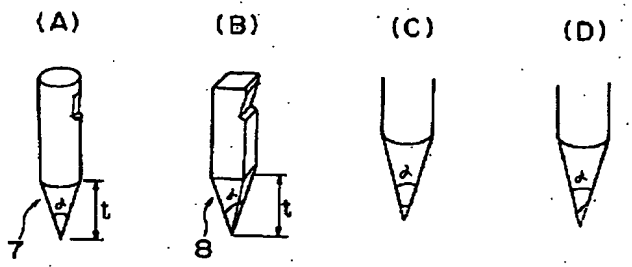
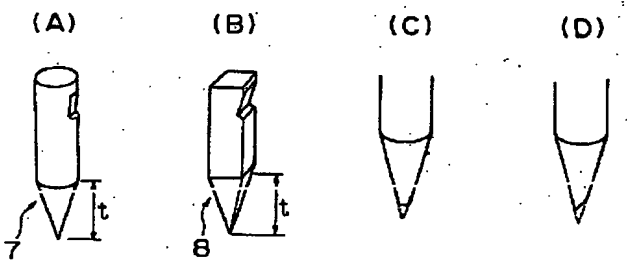
DRAWINGS

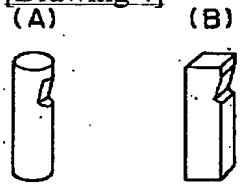
[Drawing 1]



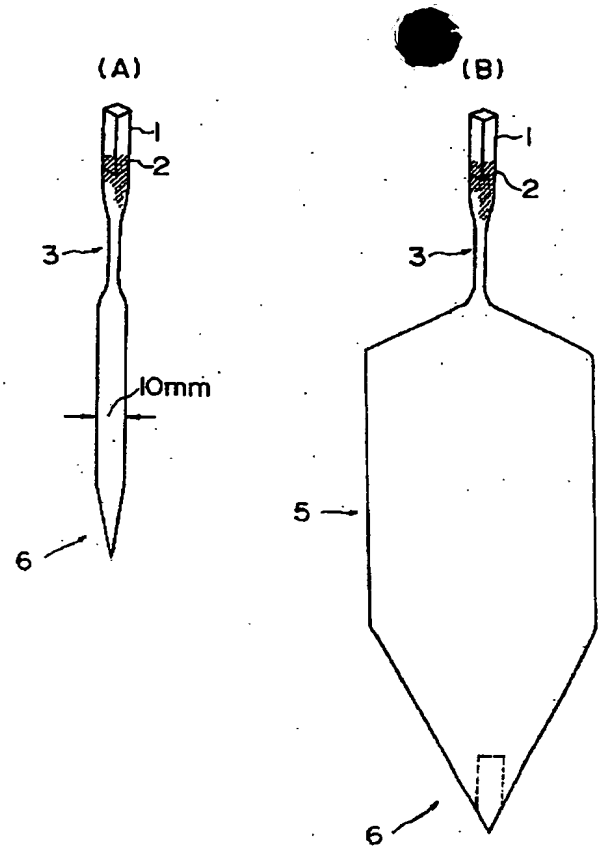
[Drawing 3]



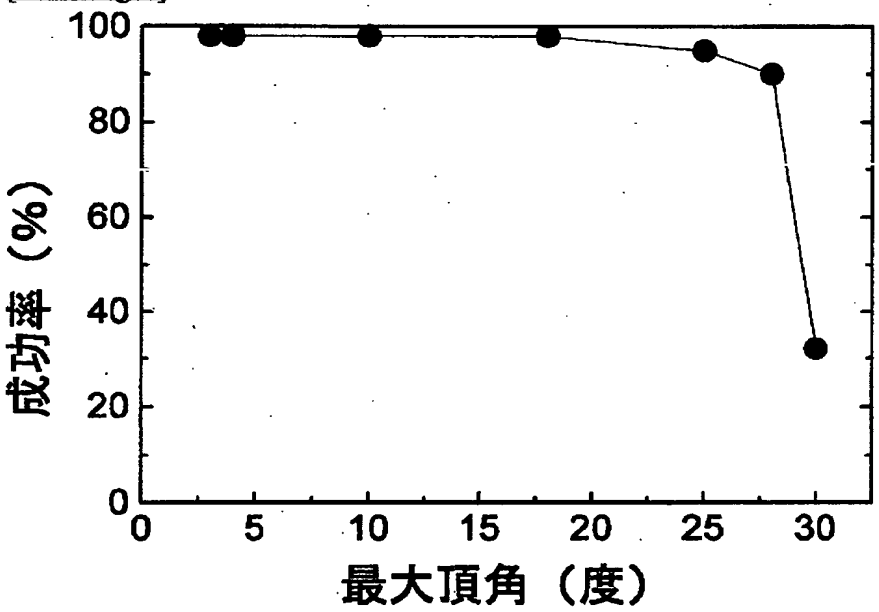
[Drawing 4]



[Drawing 2]



[Drawing 5]



[Translation done.]